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# A STUDY OF THE GRINDING CHARACTERISTICS OF A MEGAPACT GRINDING MILL

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MICROMEDIA

# A STUDY OF THE GRINDING CHARACTERISTICS OF A MEGAPACT GRINDING MILL

by

P.J.H. Prud'homme*

## SUMMARY

The grinding characteristics of a small Megapact vibratory grinding mill were evaluated using quartz and limestone as feed and, as grinding media, 6 mm tungsten carbide pebbles. Results indicated that this unit was ideally suited for comparative grinding tests on various minerals and, further, that it was particularly useful as a preliminary test unit in grinding studies in the much larger Humbolt vibratory grinding mill.

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# ÉTUDE DES PROPRIÉTÉS DE BROYAGE D'UN BROYEUR MEGAPACT

par

P.J.H. Prud'homme*

## RÉSUMÉ

On a déterminé les propriétés d'un petit broyeur Megapact à vibration alimenté au quartz et au calcaire. On a utilisé des galets de carbure de tungstène de 6 mm pour effectuer le broyage. Les résultats ont démontré que cette unité convient parfaitement aux essais comparatifs de broyage sur divers minéraux. De plus, elle constitue une unité particulièrement utile pour effectuer les tests préliminaires lors des études effectuées sur le broyeur à vibration Humbolt, dont les dimensions sont très grandes par rapport aux autres broyeurs.

## PURPOSE

To study the grinding characteristics of the Megapact grinding mill when crushing/grinding quartz and limestone.

## DESCRIPTION OF SAMPLES

- Ottawa Silica sand, -850, +425 µm
- Marmora waste limestone, crushed by cone and screened, portion used was -850, +425 µm

## DESCRIPTION OF GRINDING UNIT

The unit consists of two, 40 x 540-mm grinding tubes mounted above a vibratory motor at either side, one higher (H), the other slightly lower (L). Grinding is accomplished by the vibratory action of grinding media (tungsten carbide - TC) on the material to be ground (quartz sand and waste limestone). Grinding media provided with the mill consists of 6-mm tungsten carbide pebbles. The H and L grinding chambers may be operated separately or in series. When in series, the discharge from the H side passes through a connecting plastic tube to the L side chamber. The volume of each grinding chamber is about 600 mL. The bulk density of the tungsten carbide is about 8.3 g/mL and that of the quartz sand and limestone about 1.6 g/mL. Thus one volume of the former is equivalent to about five volumes of the latter from the standpoint of weight. For this experiment, the grinding chambers were about half full (300 mL). Grinding tests were conducted in the H and L chambers separately, i.e., not connected, for 5, 10 and 15 min periods using, as charge, various quantities of TC pebbles and sand or limestone as noted in Table 1.

Sixteen tests were run, 6 in the lower chamber (L), 10 in the upper (H), for 5 to 15 min periods. Product was screened on 500 and 100-µm screens and the results tabulated and plotted on graphs. Results are noted in Tables 2 to 5 and in Fig. 1 to 14. Data for test A and A1 are not recorded as the size reduction of the ground materials was insignificant.

## Discussion

The results of this study show that the degree of grinding is proportional to both the pebble charge and grinding time. For quartz, as the pebble charge is increased from 100 mL (Test B) to 200 mL (Test D), the percentage of +35 mesh material decreases from 88.7% (5 min., H chamber) to

36.6% (5 min, H chamber). Corresponding values for the 15 min grinding period were 69.3 and 4.5% respectively. Thus a greater size reduction can be achieved by either increasing the pebble charge or grinding time, or both. Grinding to 5% -150 mesh may be accomplished using 100 mL of pebbles and grinding for 15 min or, alternately, using 150 mL of pebbles and grinding for only 5 min.

Although some differences were noted in the grinding action of the H and L chambers, the H chamber generally grinding finer than the L, this difference was not particularly significant. Fine grinding, to 100% -150 mesh, required a significant increase in pebble charge to sand ratio, and grinding time, e.g., 250 mL pebbles: 50 mL sand for 15 min (Test E).

Results with limestone were comparable to those obtained with the quartz although limestone, being somewhat softer, generally required a lower grinding pebble to limestone ratio than quartz for a comparative size reduction. Somewhat surprisingly, in the finer, 100% -150 mesh grind, the quartz appears to grind more easily than the limestone (compare Tests E and $E_1$, 15 min grind). Although no test was conducted with the H and L chambers connected, this unit may be so employed. Here, the degree of grinding would depend on the feed rate as well as the charge in both the H and L chambers. Grinding action would presumably be highly variable until a uniform ratio of grinding media to feed material has been established in both the H and L chambers. This presumably would be the case when rate of feed to the high side was equal to the rate of discharge from the low side.

## Conclusion

The Megapact grinding mill is an ideal unit to study and compare grindability of minerals and, in this regard, may ideally be used as a preliminary test unit in grinding studies conducted in the much larger Humbolt vibratory mill. Further studies, with H and L chambers connected to more closely duplicate the grinding action of the Humbolt, should be undertaken.

Table 1 - Grinding charge/chambers

| Test | Charge (mL) | | | Grinding chamber | |
|---|---|---|---|---|---|
| | TC pebbles | sand | limestone | high | low |
| A | 50 | 250 | - | x | |
| $A_1$ | 50 | - | 250 | x | |
| B | 100 | 200 | - | x | x |
| $B_1$ | 100 | - | 200 | x | x |
| C | 150 | 150 | - | x | |
| $C_1$ | 150 | - | 150 | x | |
| D | 200 | 100 | - | x | x |
| $D_1$ | 200 | - | 100 | x | x |
| E | 250 | 50 | - | x | x |
| $E_1$ | 250 | - | 50 | x | x |

Table 2 - Size analysis, Tests B, B1

| Sieve size µm | Test B - quartz (wt %) | | | | | | Test $B_1$ - limestone (wt %) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 min | | 10 min | | 15 min | | 5 min | | 10 min | | 15 min | |
| | H | L | H | L | H | L | H | L | H | L | H | L |
| +500 | 88.6 | 91.5 | 77.2 | 86.1 | 69.3 | 69.9 | 73.0 | 74.0 | 64.0 | 74.8 | 53.5 | 64.8 |
| -500 +300 | 6.1 | 5.1 | 11.0 | 7.7 | 13.9 | 15.2 | 15.0 | 14.6 | 18.6 | 14.1 | 20.4 | 17.5 |
| -300 +200 | 1.9 | 1.3 | 4.1 | 2.4 | 5.5 | 5.4 | 4.7 | 4.4 | 6.2 | 4.4 | 8.2 | 5.9 |
| -200 +150 | 1.2 | 0.8 | 2.8 | 1.5 | 3.8 | 3.5 | 2.9 | 2.8 | 3.9 | 2.7 | 5.5 | 3.8 |
| -150 +100 | 0.7 | 0.4 | 1.6 | 0.8 | 2.2 | 1.9 | 1.6 | 1.5 | 2.1 | 1.4 | 3.1 | 2.0 |
| -100 | 1.5 | 0.9 | 3.3 | 1.5 | 5.4 | 4.1 | 2.8 | 2.7 | 5.2 | 2.6 | 9.3 | 6.0 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Table 3 - Size analysis, Tests C, $C_l$

| Sieve size µm | Test C - quartz (wt %) | | | Test $C_l$ - limestone (wt %) | | |
|---|---|---|---|---|---|---|
| | 5 min | 10 min | 15 min | 5 min | 10 min | 15 min |
| | H | H | H | H | H | H |
| +500 | 68.7 | 51.1 | 26.7 | 62.4 | 40.0 | 25.3 |
| -500 +300 | 15.0 | 17.6 | 20.4 | 19.6 | 25.3 | 25.3 |
| -300 +200 | 5.7 | 9.5 | 13.7 | 6.5 | 11.1 | 14.1 |
| -200 +150 | 3.8 | 7.1 | 11.4 | 3.8 | 7.2 | 9.9 |
| -150 +100 | 2.1 | 4.3 | 7.3 | 2.1 | 4.1 | 5.9 |
| -100 | 4.7 | 10.4 | 20.5 | 5.6 | 12.3 | 19.5 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Table 4 - Size analysis, Tests D, $D_1$

| Sieve size µm | Test D - quartz (wt %) | | | | | | Test $D_1$ - limestone (wt %) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 min | | 10 min | | 15 min | | 5 min | | 10 min | | 15 min | |
| | H | L | H | L | H | L | H | L | H | L | H | L |
| +500 | 36.6 | 29.0 | 13.8 | 6.8 | 4.5 | 2.1 | 18.5 | 27.7 | 6.1 | 16.3 | 2.4 | 3.9 |
| -500 +300 | 17.5 | 22.1 | 10.6 | 8.1 | 3.5 | 3.0 | 23.0 | 22.8 | 6.7 | 12.2 | 0.6 | 0.4 |
| -300 +200 | 10.7 | 12.8 | 10.9 | 11.4 | 5.9 | 5.6 | 14.1 | 12.9 | 11.0 | 10.8 | 1.4 | 0.7 |
| -200 +150 | 9.1 | 10.5 | 13.5 | 16.6 | 12.6 | 12.7 | 11.4 | 9.8 | 16.5 | 11.6 | 8.5 | 7.1 |
| -150 +100 | 6.0 | 6.6 | 10.8 | 13.2 | 13.6 | 14.3 | 6.9 | 5.7 | 11.4 | 8.9 | 14.4 | 14.5 |
| -100 | 20.1 | 19.0 | 40.4 | 43.9 | 59.9 | 6.2 | 26.1 | 21.1 | 48.3 | 40.3 | 72.7 | 73.4 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Table 5 - Size analysis, Tests E, $E_l$

| Sieve size µm | Test E - quartz (wt %) | | | | | | Test $E_l$ - limestone (wt %) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 min | | 10 min | | 15 min | | 5 min | | 10 min | | 15 min | |
| | H | L | H | L | H | L | H | L | H | L | H | L |
| +500 | 31.9 | 44.9 | 7.1 | 13.2 | - | 0.8 | 4.1 | 6.7 | - | - | - | - |
| -500 +300 | 9.6 | 7.5 | 1.0 | 1.7 | - | - | 1.7 | 2.2 | - | - | - | - |
| -300 +200 | 6.9 | 5.3 | 1.1 | 1.6 | - | - | 3.6 | 3.6 | 0.3 | 0.3 | - | 0.3 |
| -200 +150 | 8.3 | 6.6 | 3.1 | 3.5 | - | 0.1 | 10.6 | 9.2 | 0.7 | 0.8 | 1.6 | 1.0 |
| -150 +100 | 7.4 | 6.0 | 6.6 | 6.0 | - | 0.4 | 12.9 | 12.0 | 2.0 | 3.8 | 6.5 | 5.2 |
| -100 | 36.0 | 29.7 | 81.0 | 74.1 | 100.0 | 98.7 | 67.1 | 66.3 | 97.0 | 95.1 | 91.9 | 93.5 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

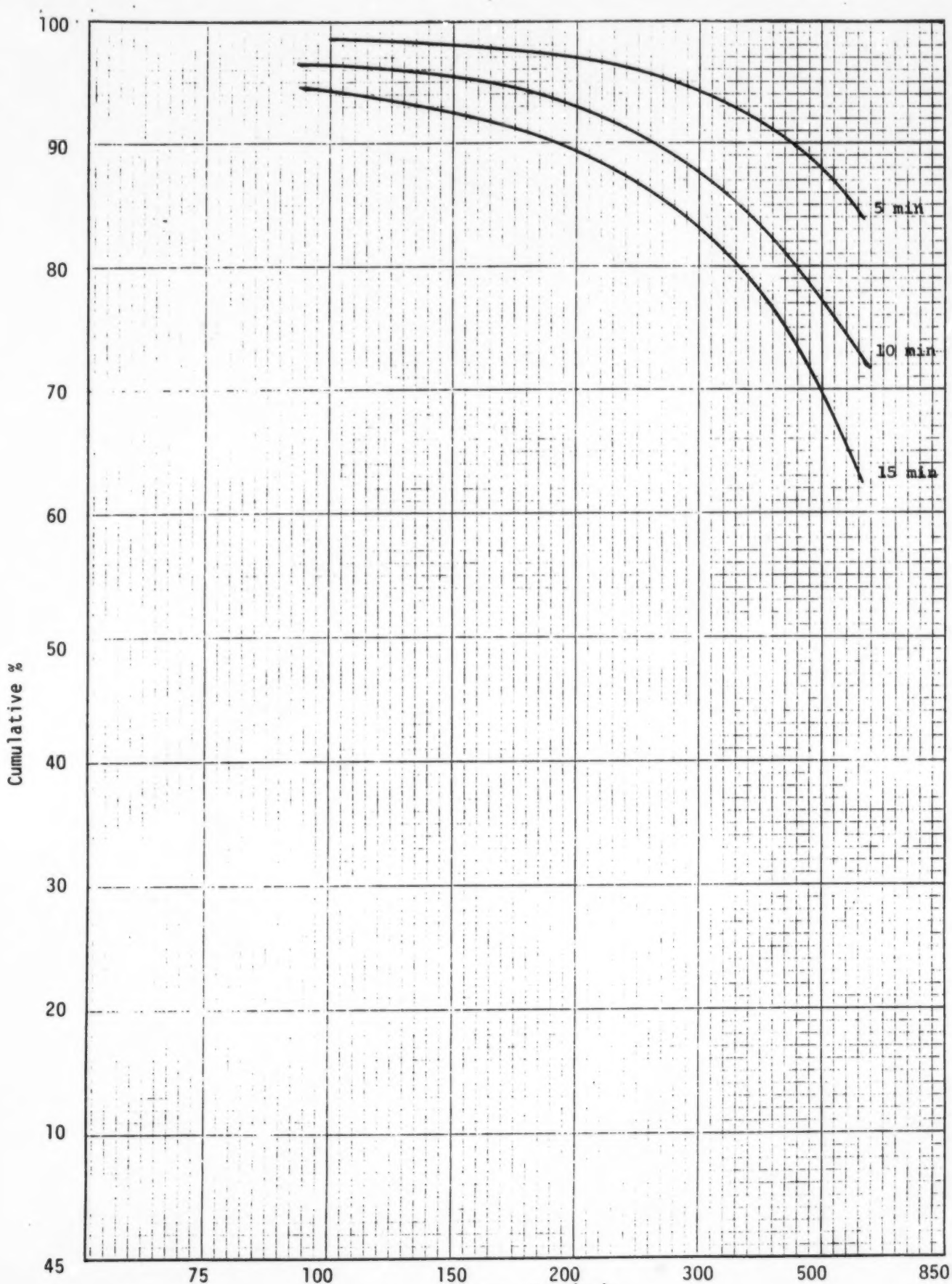



Fig. 1 - Test R. H chamber (100 ml ma

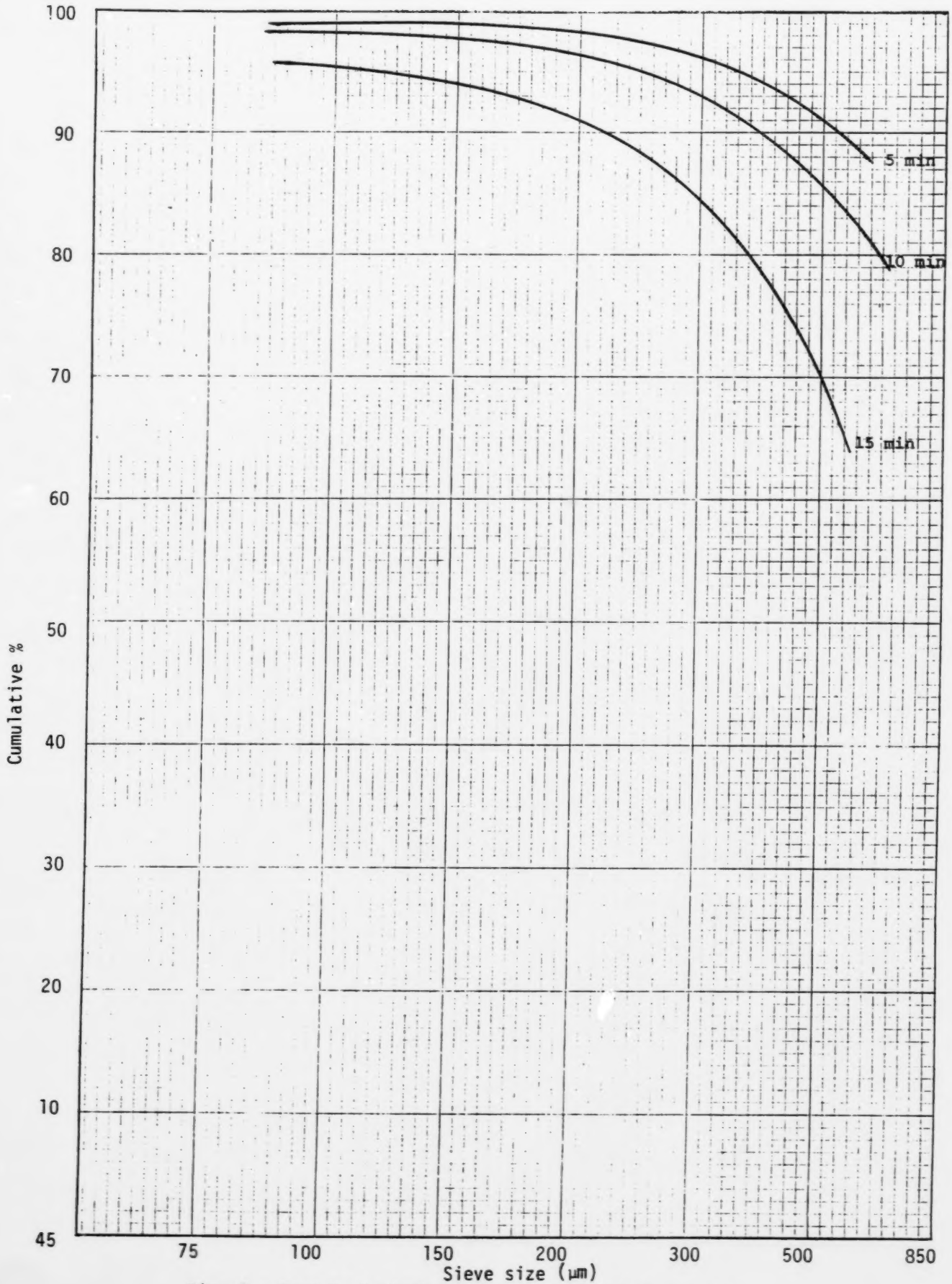
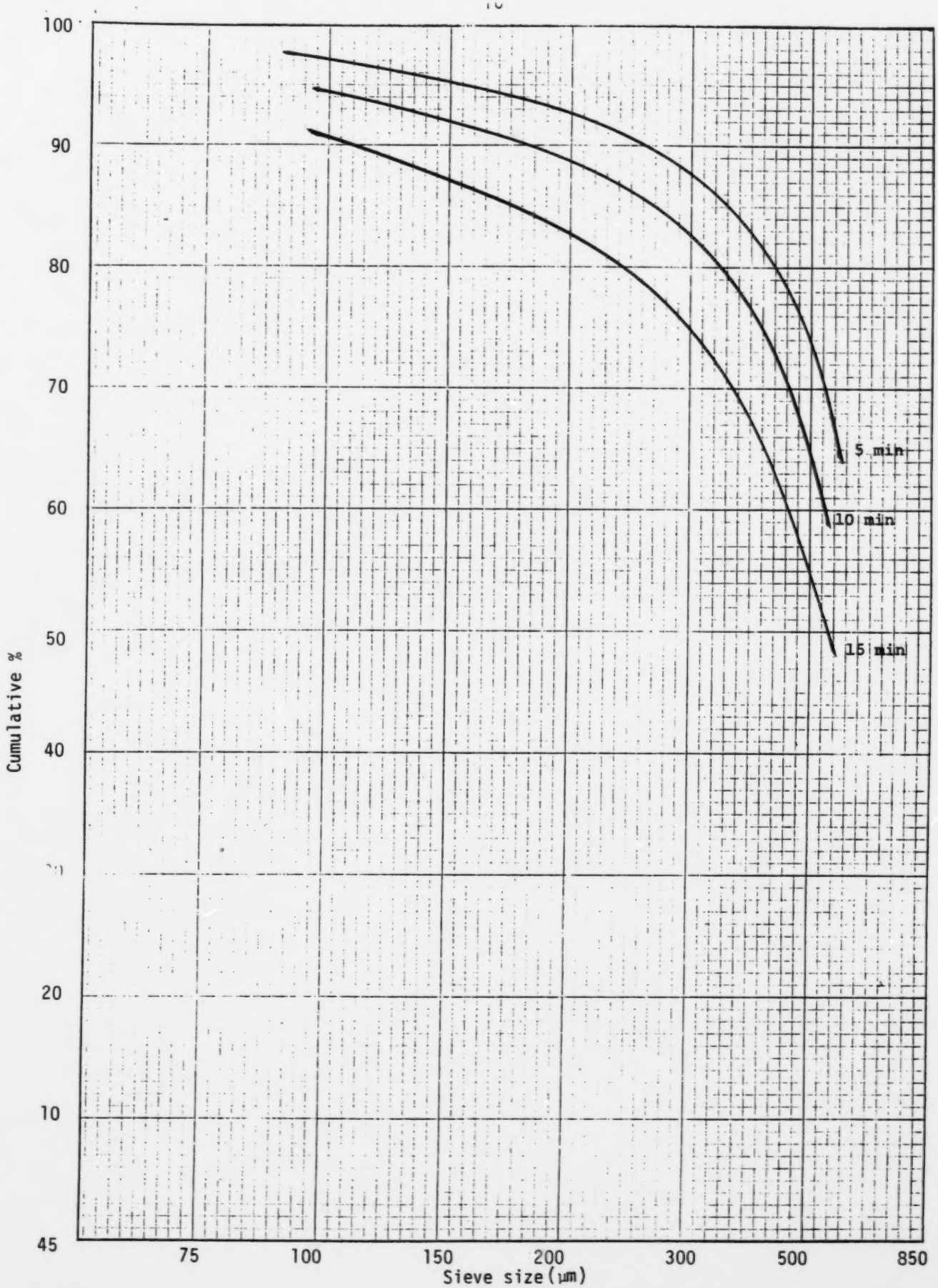



Fig. 2 - Test R. I chamber (100 ml MC + 200 ml water)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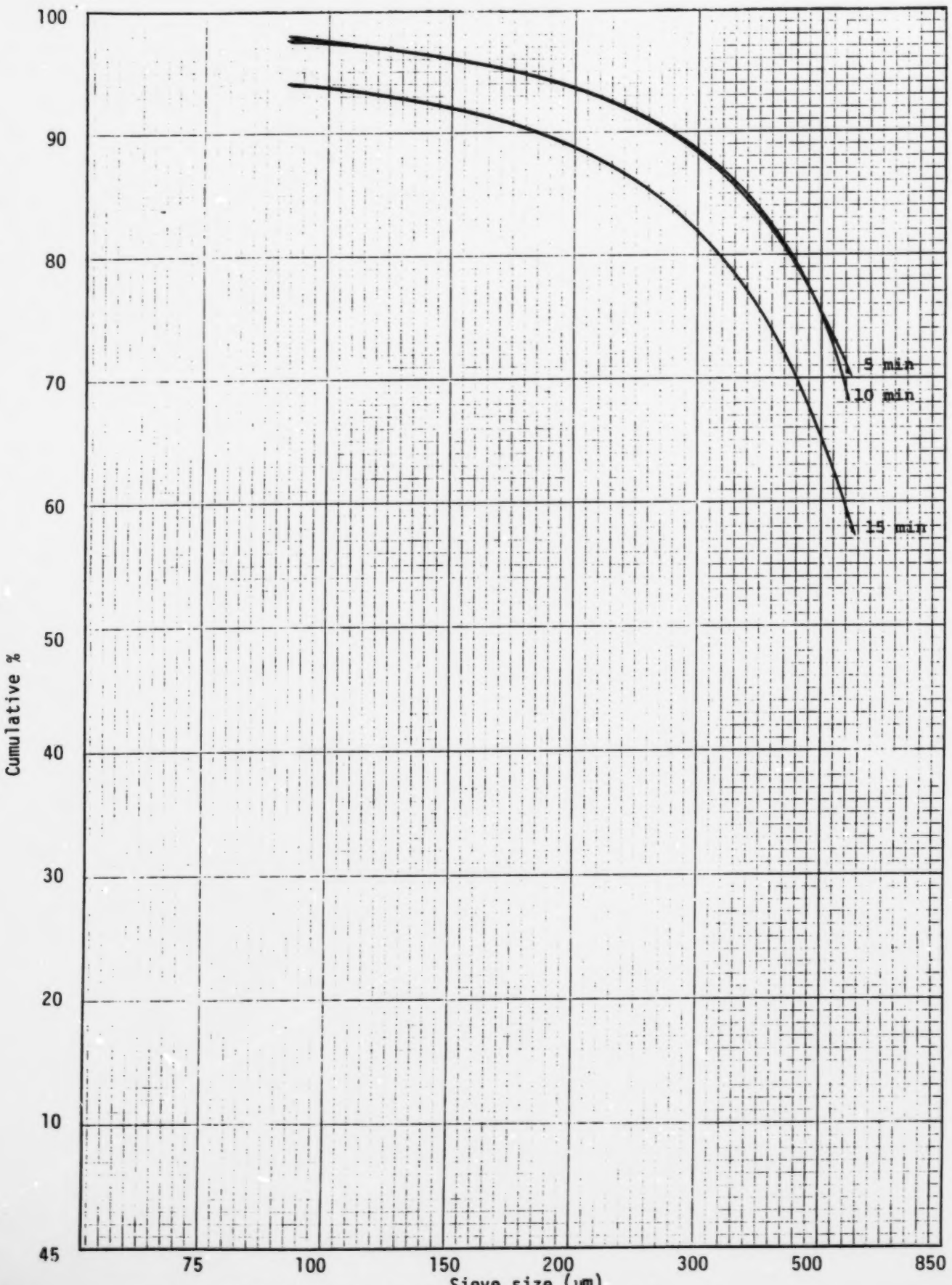
Sieve size (µm)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Sieve size (µm)

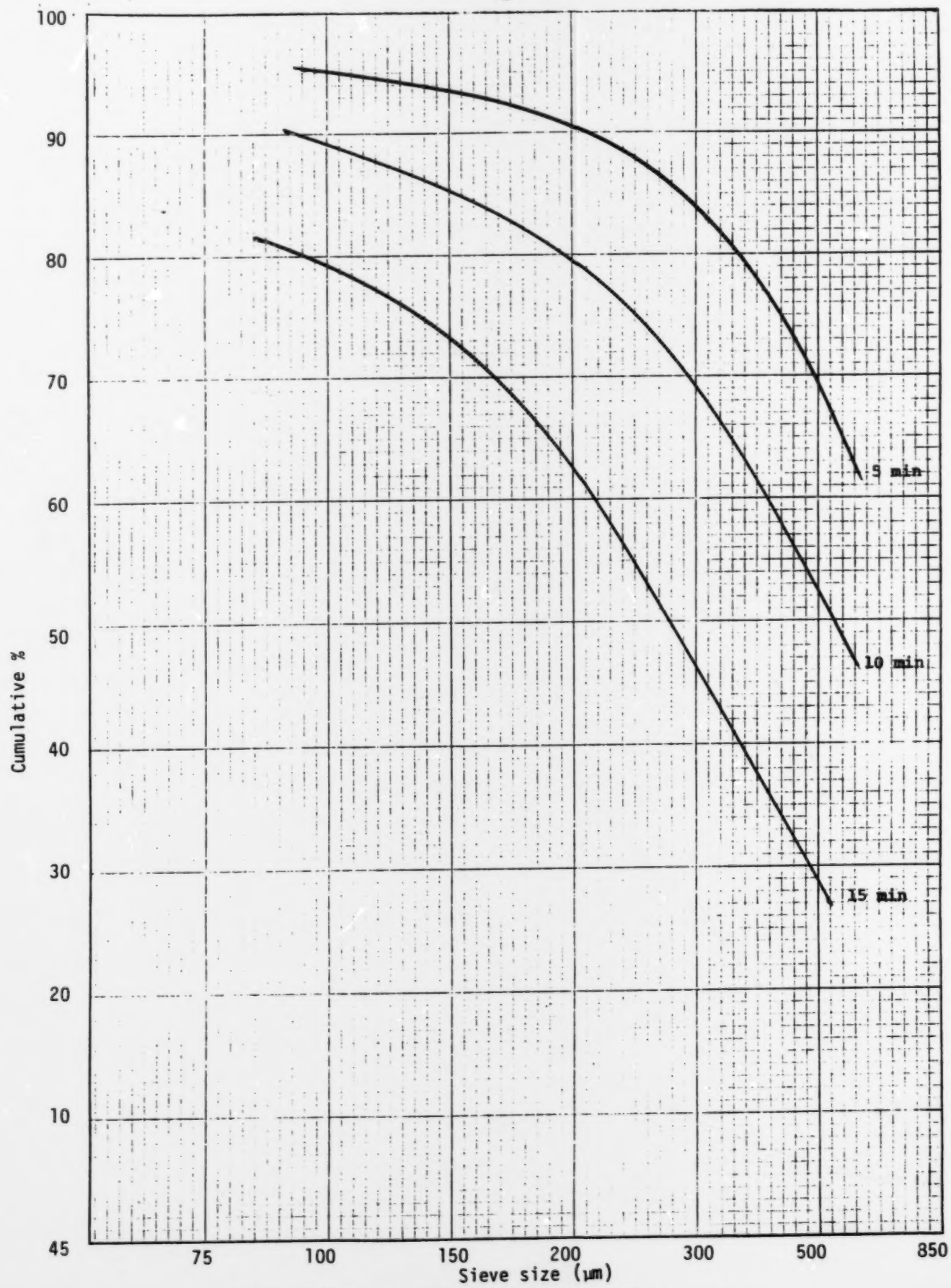
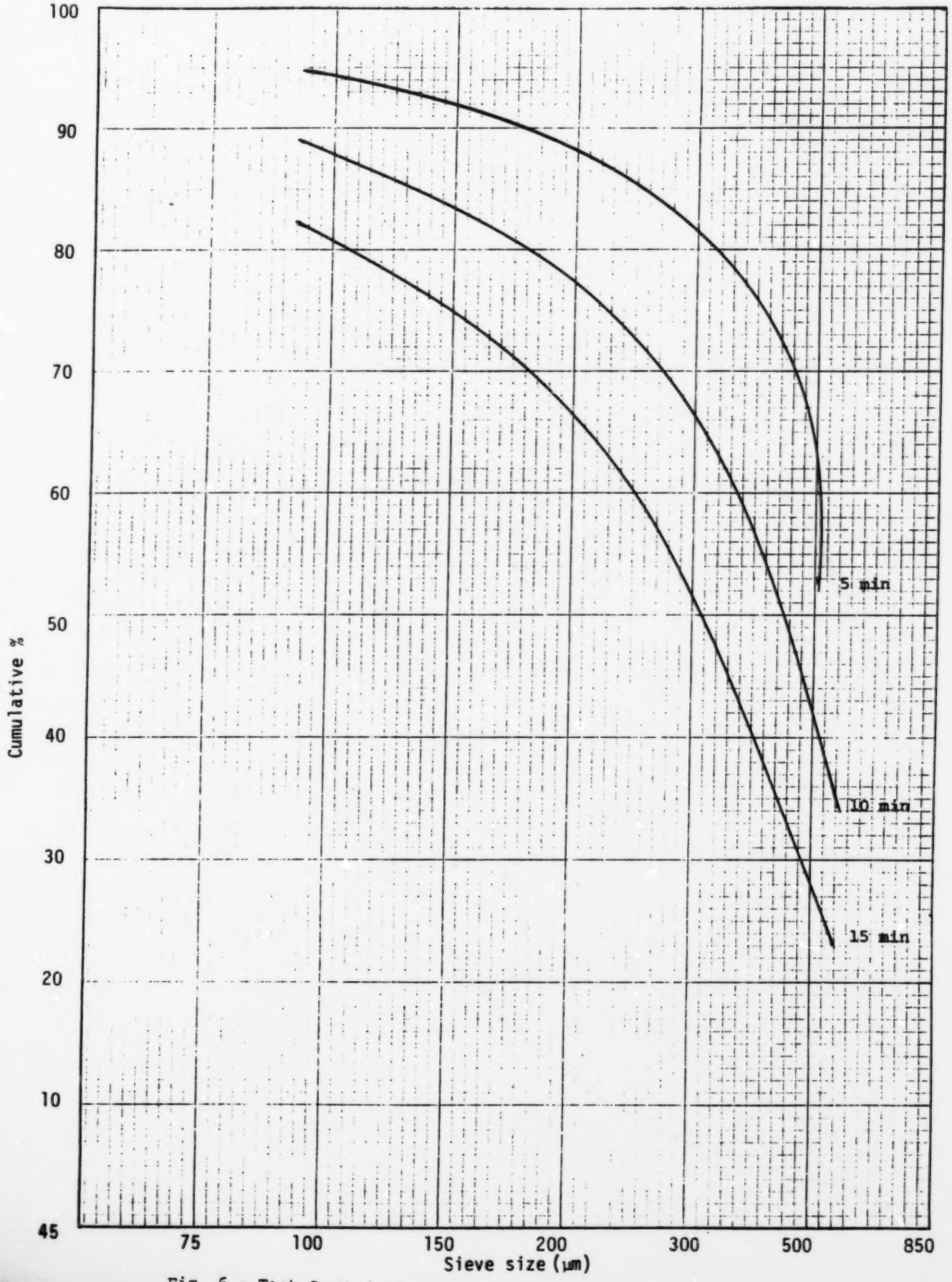



Fig. 5 - Test C. H chamber (150 ml TC + 150 ml [illegible]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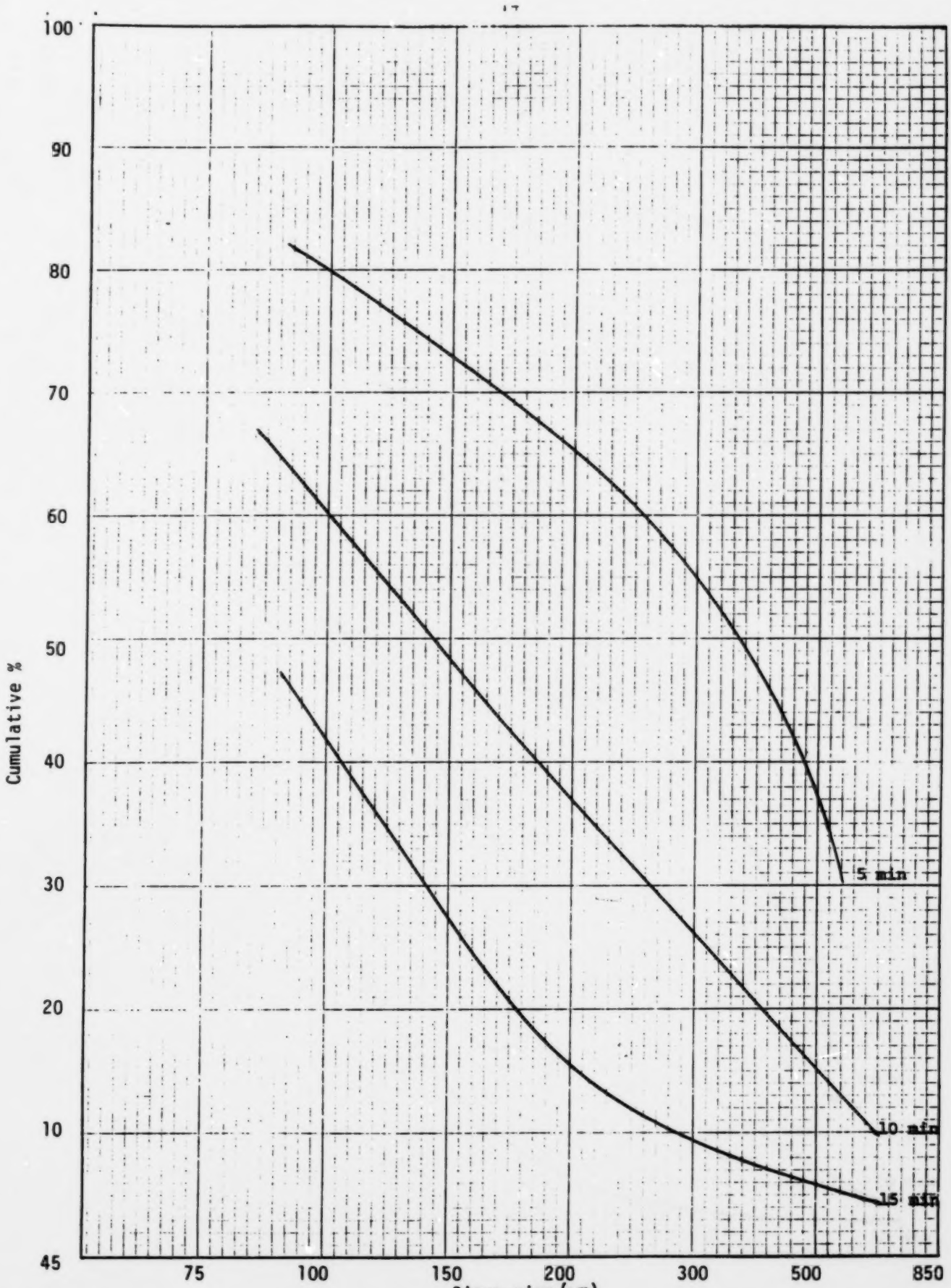
Sieve size (µm)

Fig. 6 - Test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Sieve size (µm)
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10 min
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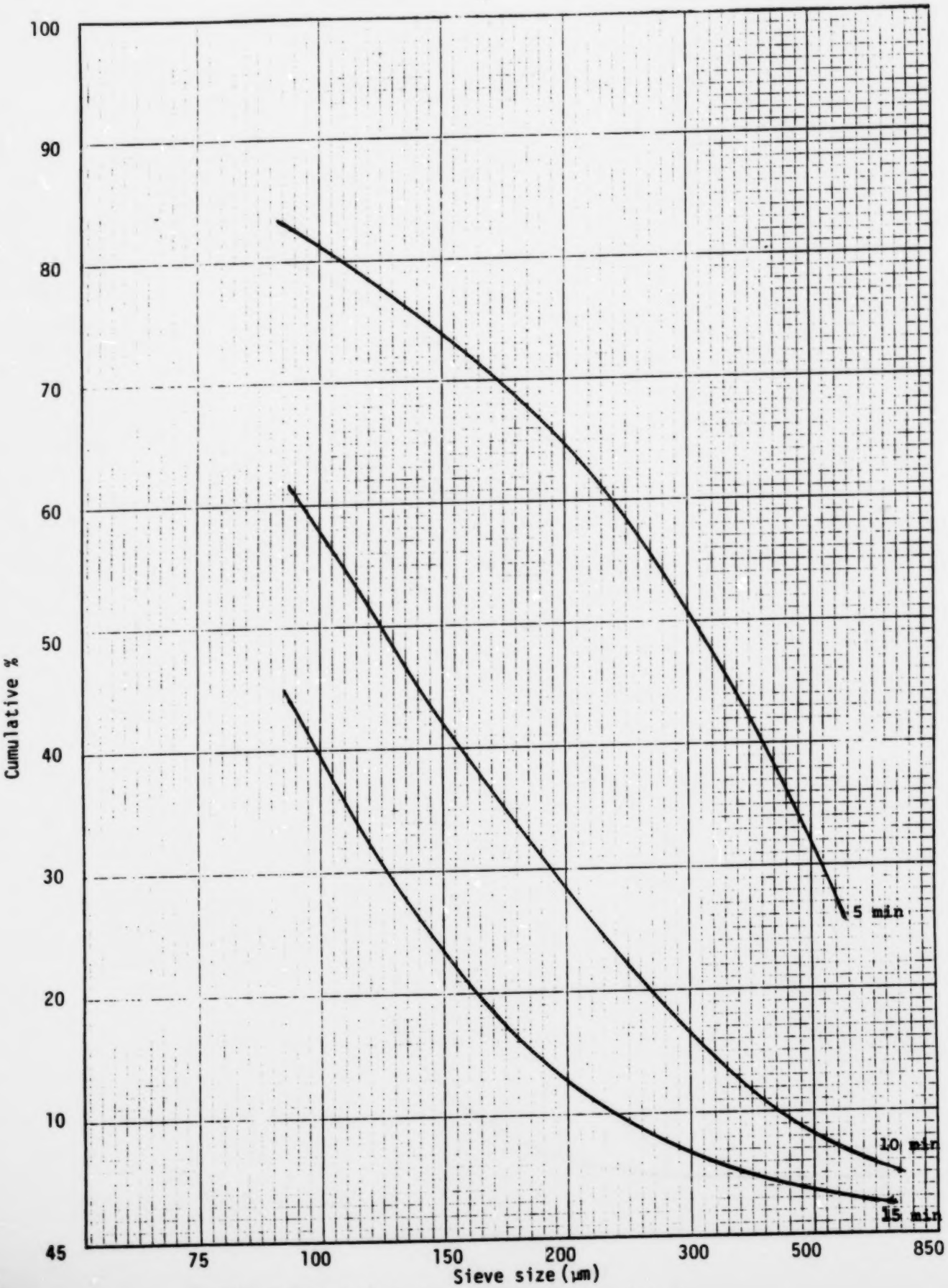
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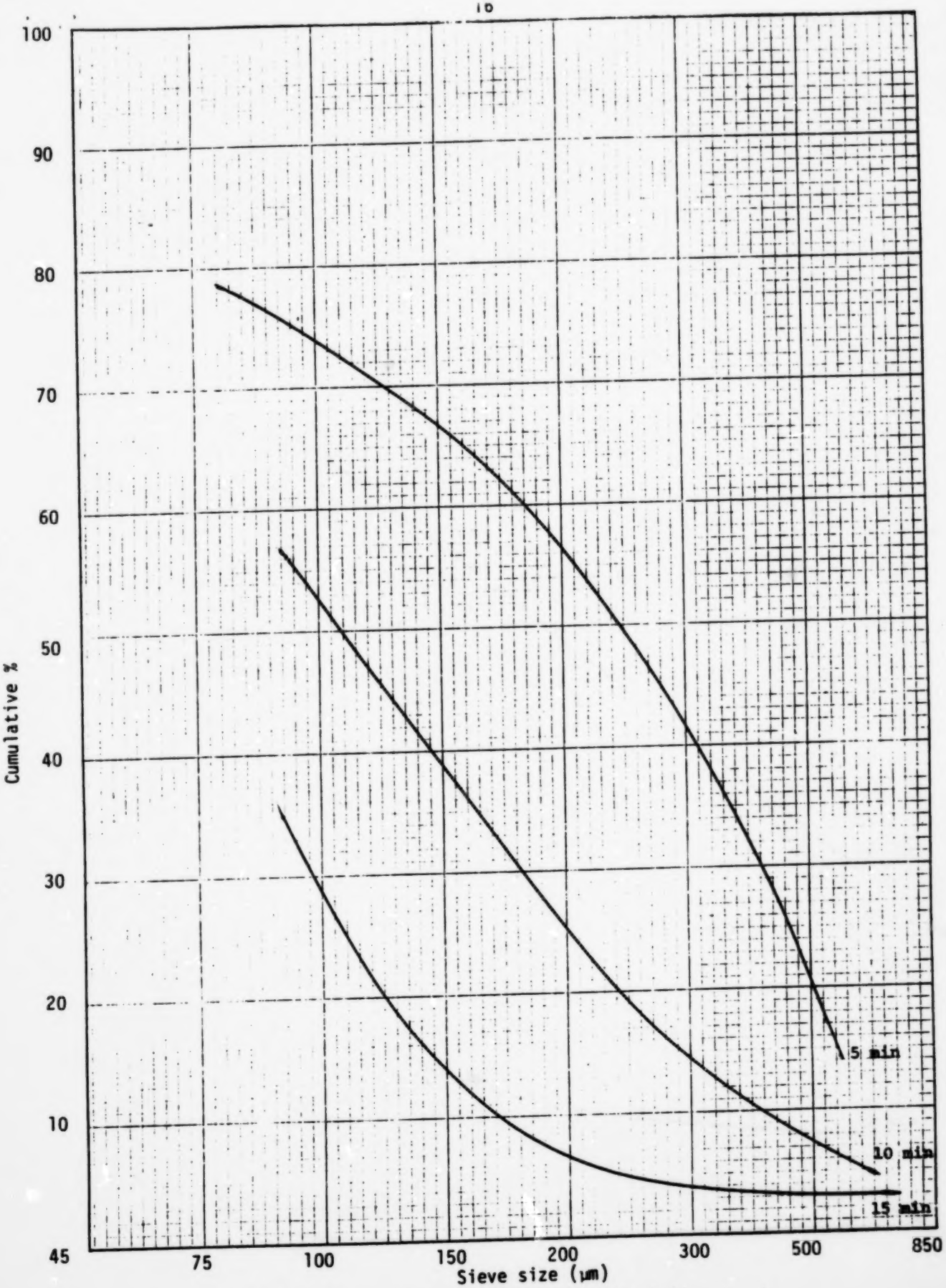
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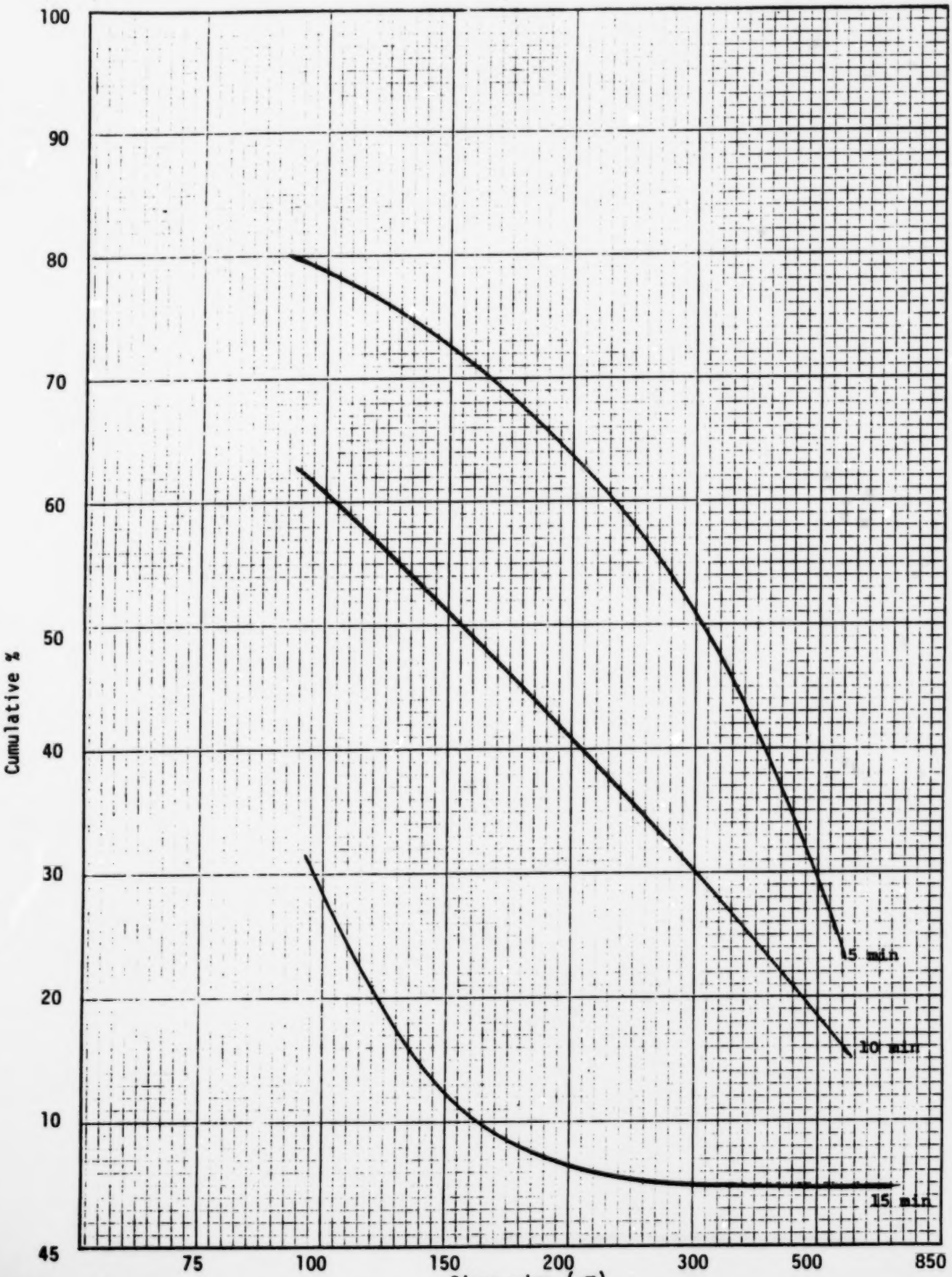
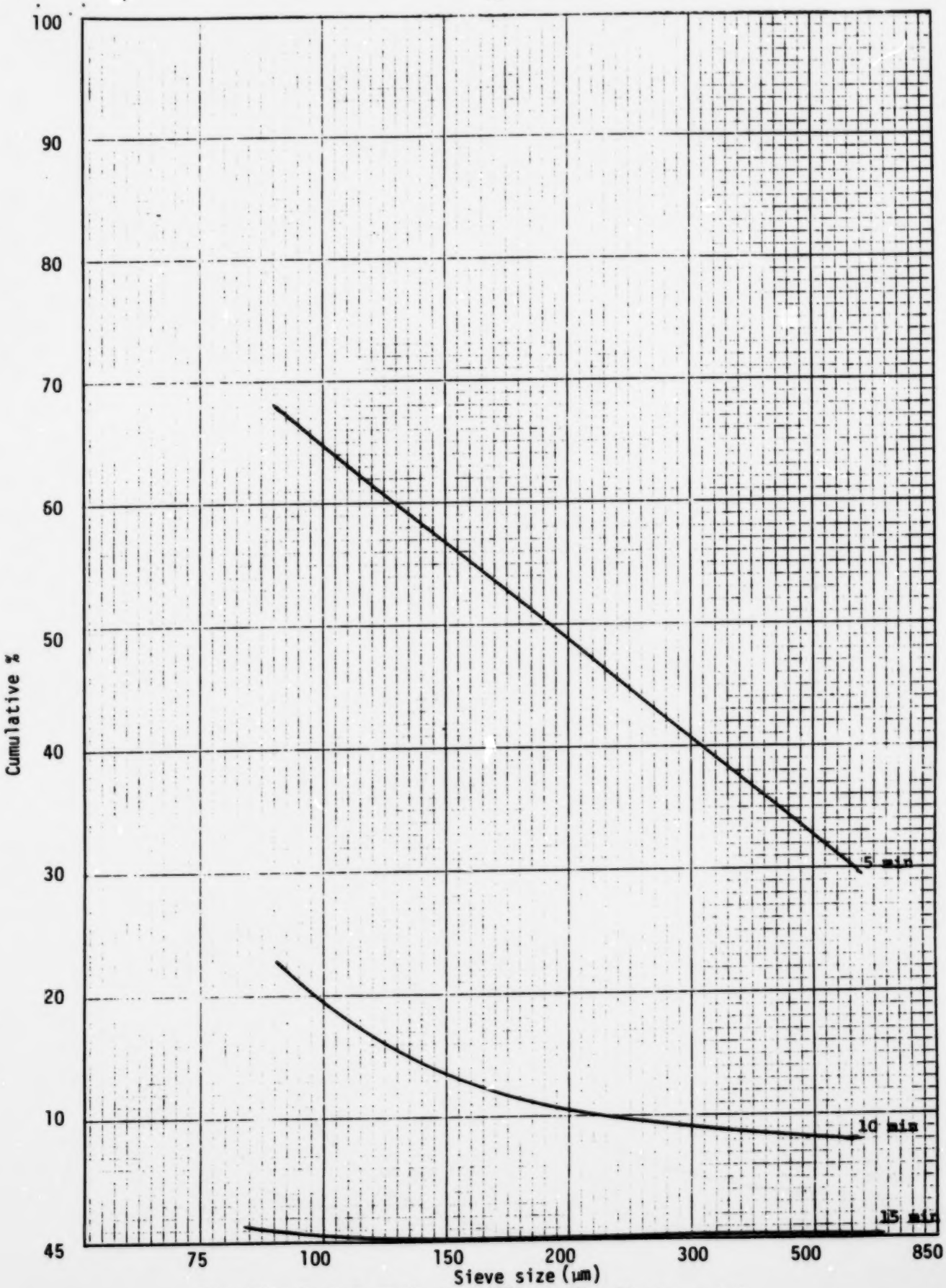



Fig. 10 - Test D, L chamber (200 mL TC + 100 mL [illegible])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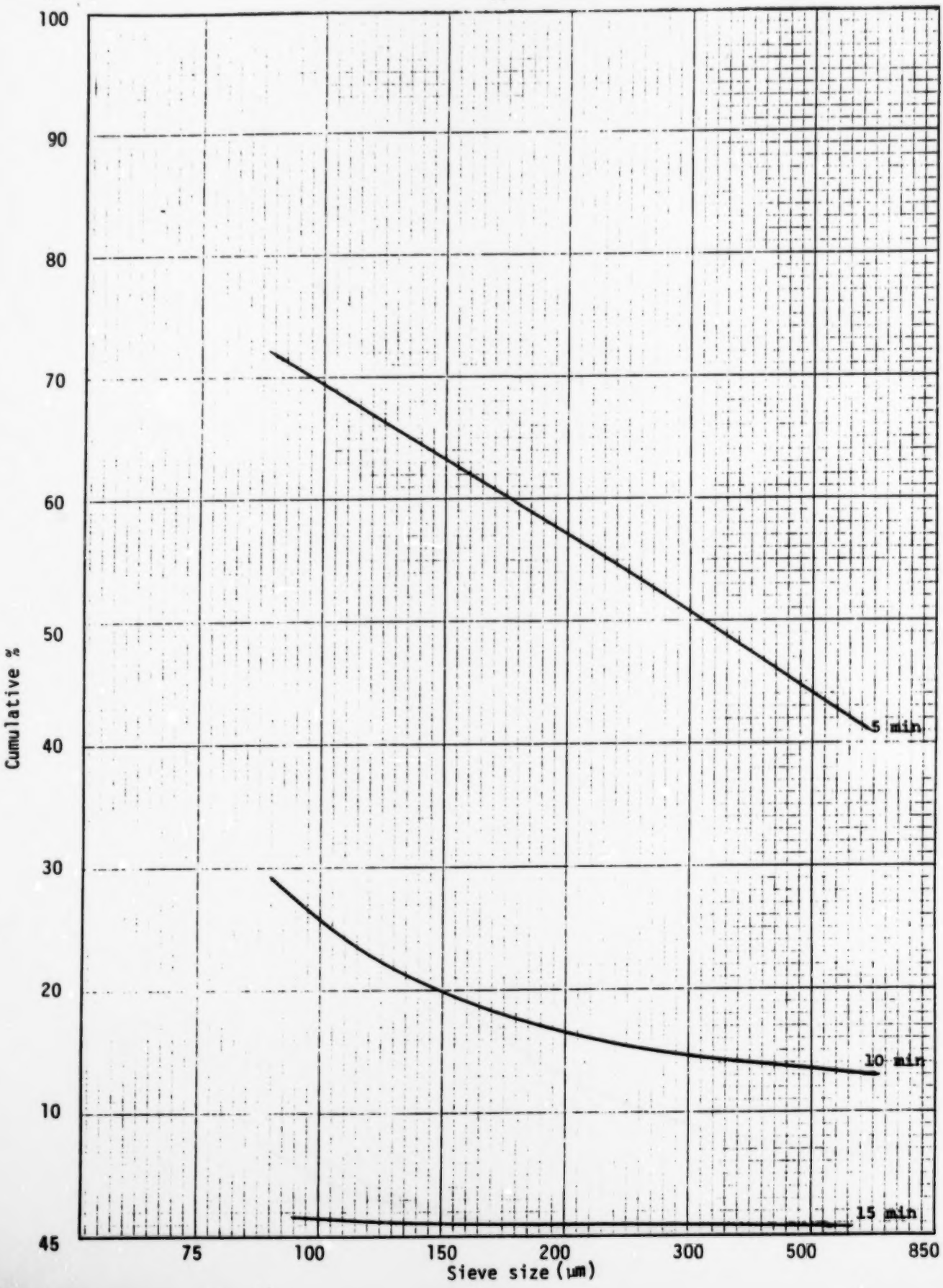
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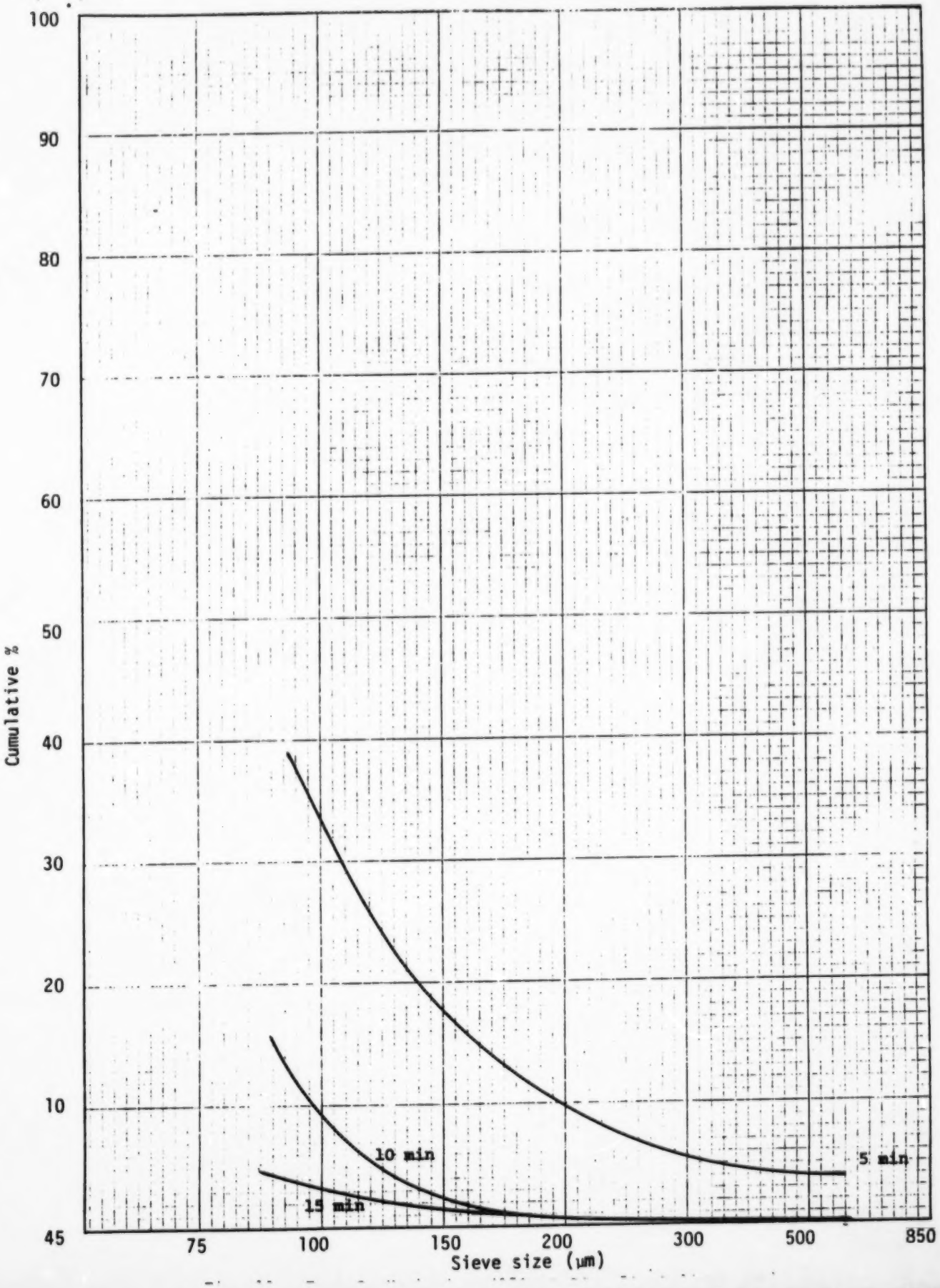
Sieve size (µm)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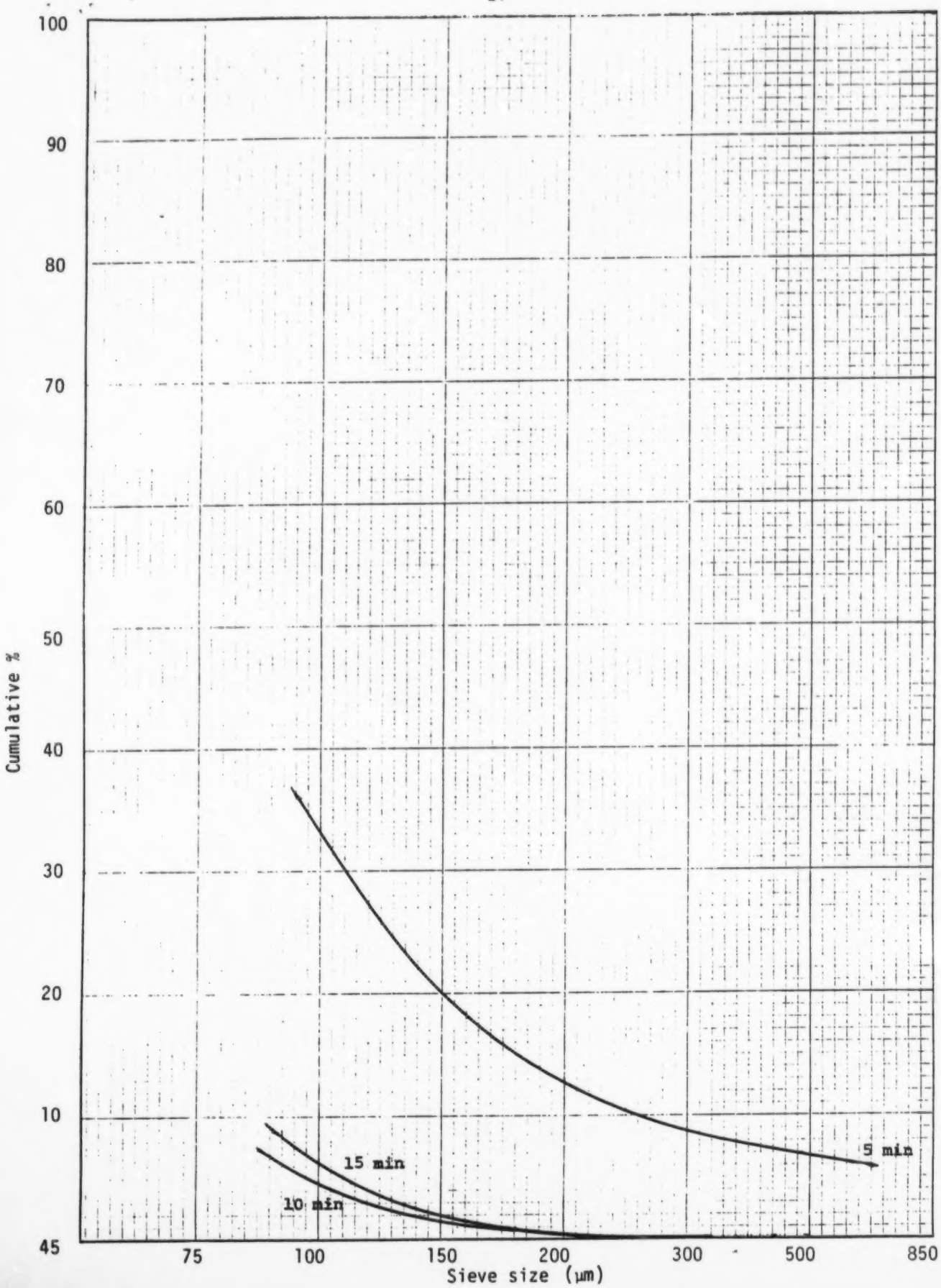
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Sieve size (µm)
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15 min
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POOR

QUALITY

ORIGINAL